NEWS SCIENCE NEWS

LONG-DELAY ECHOES
A Mysterious Radio Phenomenon

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Experiments in the 1920s

An electromagnetic anomaly called the "long-delay echo" (LDE) was first noticed nearly 80 years ago. It was originally documented in the 3 November 1928 edition of the scientific journal *Nature* by physicist Carl Störmer, in response to a letter sent to him by Norwegian radio engineer Jørgen Hals:

"...at the end of the summer 1927, I repeatedly heard signals from the Dutch short-wave transmitting station PCJJ (Eindhoven). At the same time as I heard the telegraph signals I also heard echoes. I heard the usual echo, which goes around the earth with an interval of about one-seventh second, as well as a weaker echo about 3 seconds after the principal signal had gone. When the principal signal was especially strong, I suppose that the amplitude for the last echo 3 seconds after, lay between one-tenth and one-twentieth of the principal signal in strength. From where this echo comes I can not say for the present. I will only herewith confirm that I really heard this echo."

At the time, the PCJJ station had some of the most powerful short-wave transmitters in the world. These transmitters were used to broadcast to The Netherlands' far-flung colonies around the world. They were so powerful that the signals were received with clarity and regularity in the Dutch East Indies (now Indonesia). In those days, there was much less man-made interference and congestion in the short-wave bands than there is today, so it was easier to receive signals from 10,000 kilometres or more away. This is not to say that this can't be done today; it can be done quite easily, and the receivers of today are far more sophisticated than they were in 1927.

Carl Störmer, the physicist to whom the letter was addressed, teamed up with researcher Balthasar van der Pol at Philips Research Laboratories at Eindhoven in The Netherlands. In September 1928 they started experiments of their own to verify the findings of Jørgen Hals. Using the high-power transmitters at their disposal, they radiated "call signs" at 30-second intervals on the night of 11 October 1928 on 31.4 metres or 9,554 kilohertz. The results they got indicated delays of between three and 15 seconds. This gave validity to the observations of Jørgen Hals.

In a telegram that was sent back to Störmer and reproduced in his submission to *Nature*, van der Pol noted: "Last night special emission gave echoes here varying between 3 and 15 seconds. 50 per cent of echoes heard after 8 seconds."

At the end of his studies of the phenomenon, Störmer published his findings in August 1929 and attributed the cause of the LDE phenomenon to be "auroral in nature".

In May 1929, France sent an expedition to French Indo-China (now Vietnam) to study an eclipse of the Sun. G. Talon, captain of the vessel *L'Inconstant*, and J. B. Galle were given orders specifically to study the effect of the solar eclipse on radio propagation, particularly the LDE phenomenon. They used a 500-watt transmitter for this purpose. With another vessel, *La Pérouse*, they set sail from Saigon on 2 May, and on 5 May they conducted test transmissions and detected long-delay echoes. On 6 and 7 May they couldn't operate due to inclement weather, but on 8 May they were on the air again and were transmitting for the first 10 minutes of every half-hour. On 9 May, the day of the eclipse, they sent signals for nearly six hours with one 20-minute break. The following day they again sent signals for the first 10 minutes of every half-hour. These signals were sent in Morse code for every 30 seconds on 25 metres or 12,000 kilohertz wavelength. Special considerations were made to make it easier to identify and time the signals.

Apparently, large numbers of echoes were heard. These were divided into two groups: weak echoes, about 1/100th the original signal strength, and strong ones, about one-third to one-fifth the intensity of the original signal strength. There was no noticeable relationship between signal strength and delay time.

In their report, Galle and Talon said the echoes stopped altogether during the totality of the eclipse, but in fact the echoes paused for three-and-a-half minutes before the eclipse became total and began again halfway through it. Delay times ranged from one second to 30 seconds, although two 31-second echoes and one of 32 seconds were heard between 3:40 and 4:00 o'clock on the day of the eclipse. One- and two-second echoes might seem impossible for a probe in the Moon's orbit unless there were some highly unusual circumstances. (Some were attributing the LDE phenomenon to alien space probes.)

At 2:19:29 on the day of the eclipse, the operator "forgot" to send the required dots, but five- and 10-second echoes were heard anyway. From this, Galle and Talon came to the conclusion that some echoes might have a delay of 40 seconds or more: either their musical tone sequence let them down, or they were unable to believe evidence that the probe was anticipating their signals as it transmitted its "replies". The overall intensity of the echoes decreased as the Sun approached the horizon, as we would expect if there were a probe in the Moon equilateral position descending from the meridian. A diagram they published gave an idea of the complexity of the echo patterns and the difficulty of transcribing them.

Postwar research into LDEs

Interest in the LDE phenomenon seemed to die out by the mid-1930s, but new studies were undertaken after the war in 1947 to 1949. Researchers Budden and Yates, of Cambridge University in England, set up transmitters of 1 kW and 30 kW, transmitting on frequencies of 13,400 and 20,600 kilohertz (22.38 and 14.56 metres). An antenna was set up so as to emit the radio waves in a vertical direction. It was hoped that a certain number of the radio signals would travel out into space and hit "ionised clouds", which were theorised by the researchers as being sent out by the Sun towards Earth. These "ionised clouds" would eventually be called the "solar wind", as we know it today.

Budden and Yates published the results of their experiments in 1952. During the time of their research, they sent out approximately 27,000 test signals. They detected "round-the-world echoes", but no LDE phenomenon. However, the fact that they detected "round-the-world echoes" indicates that even though their antenna arrangement was designed to send the radio waves in a vertical direction, they were detecting ionospheric reflections—just like what we detect in long-distance short-wave reception. Budden and Yates came to the conclusion that they had picked frequencies too high and that the arrangement of the transmitting antenna had too high an angle of radiation—meaning that they were transmitting in an upwards direction as opposed to horizontal in relation to the surface of the Earth.

After some scientists recorded signal reflections while doing research into plasma (electrically charged gas) in the 1960s, there was renewed interest in the LDE phenomenon.

Research was done at Stanford University between 1967 and 1971. It had been theorised that some of the effects observed in the laboratory could possibly be realised in the plasma of the ionosphere. However, this had not yet been borne out by actual research. So, a 20 kW transmitter was set up to broadcast at between 5,000 and 25,000 kilohertz. The transmitting antenna or aerial was of the "log-periodic" type, which looks somewhat like a conventional television antenna but works on a different principle. The Stanford equipment was modified a number of times. The researchers thought they had detected their first LDEs in October 1968, but had to discount these noises as interference from inside the radio equipment. In January and February 1970, they detected two long-delay echoes at 10,620 and 11,020 kilohertz, with time delays of 15 and 20 seconds. By 1971, they had detected 31 LDEs.

In all this research, it was determined that the automated means that had been set up to record the LDE pulses had been less effective than simply using the human ear. After this, scientists were much more cautious in their LDE research and much more wary of accepting the research of others.

In 1985, scientists critically re-evaluated the Stanford research on the LDE phenomenon. Some further studies were undertaken and LDEs were detected, but these measurements were discounted. The earlier Stanford research was dismissed as being related to "technical side effects". Data put forth by Canadian researcher Goodacre was also treated with some apprehension.

Amateur radio experiments

Radio amateurs such as Goodacre have long provided the most comprehensive data on the LDE phenomenon.

Goodacre detected eight possible LDE effects and eventually wrote them up in a scientific paper. In 1978 and 1979 he had been doing his experiments in the vicinity of Ottawa, Ontario, Canada, using frequencies of around 28,000 kilohertz (10-metre amateur band), a highly directional antenna and a 400-watt transmitter. Goodacre sent out pulses using an automatic Morse code–sending device. He was transmitting radio waves in the direction of the western horizon when communications in the 10-metre band became poor. (Note that the 10-metre amateur band is normally only useful for long-distance communications when there is continuous daylight between the stations communicating with each other.) In other directions, communications were already impossible on the 10-metre band.

Goodacre noted the frequencies of interest in the band at the same time as these were recorded on tape. He did this so that the only findings that were given serious evaluation were those which had already been suspected of being LDEs. This avoided any mistakes due to the "copying effect" of magnetic tapes. Finally, Goodacre studied the tape recordings using an oscilloscope.

Signals which are called "short wave"—or, in amateur radio terminology, high frequency or HF—don't normally escape the ionosphere (the charged layers in the upper atmosphere that reflect radio signals). These short-wave signals, which are from 2,000 to 30,000 kilohertz, bounce in multiple hops from ionosphere to ground and back again, and can be received around the world. Science tells us that these signals eventually attenuate and die out.

Some ham radio operators like to bounce their signals off the Moon (which is at a distance of between 221,460 and 252,760 miles from the Earth), but they use much higher frequencies, usually in the region of 400 megahertz (400,000 kilohertz); these signals can pass through the ionosphere with impunity. When the amateurs bounce their signals off the Moon, they experience a 2.7-second delay from the time of transmitting the signal to receiving it. If one were to bounce a signal off Venus, it would take a few minutes or more from transmission to reception, depending upon the distance between Earth and Venus at that time.

It seems highly unlikely that much of the short-wave radiation that PCJJ or radio hams broadcast back then could have leaked into outer space and been reflected back to Earth, then again encountering the ionosphere and being attenuated again. The strength of this signal would have been so minuscule that it wouldn't have been detectable with the equipment of the time.

Theories about the LDE phenomenon

There have been a number of theories put forth over the years as possible explanations for the LDE phenomenon.

According to one theory, the radio signals are indeed passing through the ionosphere and bouncing off the Moon or planets. This might explain some occurrences but, as was mentioned earlier, the time delay from the Earth to the Moon and back again is always in the vicinity of 2.7 seconds. Venus and Mars would be in the minutes region, depending on how far away they were at the time; and considering that they are small points of reflection, the returning signal would be very small indeed. (The lack of observable consistency in the timing of the echoes is one of the characteristics of the LDE phenomenon.)

Another theory is that the signals are extraterrestrial in origin. This idea was put forth by radiophysicist Professor Ron Bracewell. It basically states that our signals are being intercepted and retransmitted by alien space probes that were placed in near-Earth orbit aeons ago, finally announcing their presence to us because we have now reached a technological level to receive the signals and investigate them. In light of today's great interest in the UFO phenomenon, this theory should be worthy of consideration in UFO circles.

Finally, there is a theory which is strictly ionospheric in origin, put forth by D. B. Muldrew. In his 1979 article "Generation of Long Delay Echoes", he examined the various ways that the ionosphere might cause radio waves to be delayed. He was of the opinion that ducting in the ionosphere could have the ability to trap radio waves for a certain amount of time. Short delays of up to a second could possibly be accounted for by this. Longer delays needed to be given further explanation. Muldrew suggested that a rather complex interaction between signals from separate transmitters could create (in theory) a long-lived electromagnetic wave that travels in the ionosphere. He proposed that delays of up to 40 seconds might be possible with this memory effect in the ionosphere.

The only thing to be determined is what is causing the phenomenon and why the electromagnetic waves are behaving the way they do.

What are we to make of this interesting scientific phenomenon? It has been experienced and investigated by scientists, so it is actually documented in scholarly journals. There is no doubt that there is something here. The only thing to be determined is what is causing the phenomenon and why the electromagnetic waves are behaving the way they do. Perhaps with our ever-expanding knowledge of physics, we will eventually have all the tools at our disposal to piece all of the puzzle together.

We hope that one day soon, the money can be made available to investigate the LDE phenomenon further with more modern technology. Perhaps these investigations could lead to ways of improving radio-wave propagation or even finding new ways of storing data. Scientific enquiry knows no limits, so let's explore! ∞

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Frank Simonsen has been an electronics professional for 25 years and an amateur radio operator and electronics hobbyist since his youth. He has a fascination with most areas of science, especially the offbeat and unusual. Mr Simonsen has lived in British Columbia all his life, and has been strongly influenced by the natural beauty of his surroundings, becoming an amateur naturalist and conservationist. He can be reached by email at frank19600@hotmail.com.